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The Purification and Analysis of

Direct Cotton Dyestuffs

and their Estimation on the Fiber

By S. M. NEALE

THE direct cotton colors are available commercially in a very wide range of shades and dyeing properties, and at prices which, considering their complexity of constitution, are very low indeed. It is, however, by no means an easy matter to obtain them in a pure state. The commercial products contain inorganic salts—large quantities of sodium chloride or sulfate are commonly added by the makers—unconverted intermediates and organic impurities, including isomers of the dyestuff, arising from the manufacturing process, and sometimes other colors added in adjustment of shade. Such materials are unsuitable for research purposes—some technical dyes only contain about 25% by weight of pure dyestuff—and the manufacturers are as a rule unable to supply dyes in a chemically pure condition.

The Purification of Direct Cotton Colors

Various methods have been suggested for the purpose of obtaining the pure color from the commercial product. Methods involving dialysis are commonly used in Germany, but these are very slow, and give only a very small yield of dyestuff which has been partially converted, as a result of membrane hydrolysis, into free dye acid. It is almost impossible to neutralize this free acid at all accurately. All other non-dialyzable impurities are retained with the dyestuff. This method has, in fact, little to recommend it. Various other methods have also been used by other workers but experience in the author's laboratory has shown that by far the best method is that involving repeated salting out with sodium acetate followed by extraction with alcohol. The commercial product is first obtained in the "concentrated" or "batch" condition, i.e., before salt has been added to reduce it to the "standardized" condition. About 50 gms. of this material are dissolved in a liter of boiling water and then salted out by the addition of a sufficient quantity of a saturated solution of sodium acetate. Many dyestuffs give at this stage a slimy precipitate which cannot be filtered, but this can be corrected by re-heating, adding a sufficient quantity of absolute alcohol, and allowing to cool again. The precipitate is then filtered at the pump, washed with sodium acetate solution, taken up with hot water and the whole process of precipitation and filtration repeated two or three times. Before the last precipitation the solution is filtered hot to remove insoluble impurities such as oxide of iron. The precipitate is finally boiled two or three times with absolute alcohol, so as to remove sodium acetate. It is not possible to give definite instructions as to the amounts of water, sodium acetate, and alcohol which should be added. These must be adjusted by trial and error to suit the particular dyestuff, bearing in mind the fact that the precipitate is less "slimy" and more easily filterable, the greater the amount of alcohol added. Details of the purification of Sky Blue FF, which is a color unusually difficult to salt out, are given by Neale and Stringfellow (Trans. Faraday Soc., 1933, *29*, 1167). This process of repeated precipitation is rather a tedious one, and difficulty may be experienced in working out the optimum conditions for certain dyestuffs, but if properly carried out a useful yield of the dyestuff in a high state of purity is obtained.

Hygroscopicity of Dyestuffs

In the author's laboratory a large number of direct cotton colors have been prepared in a pure state for use in quantitative measurements of their absorption on cellulose, and in all cases they have been found very strongly hygroscopic. This was first observed in attempting to obtain a "dry weight" in an electric oven, when it was found that weight was steadily lost as the temperature of the oven was increased. Sky Blue FF and Benzopurpurine 4B lost about 2% in weight on raising the oven

temperature from 100° to 140° C., but above 140° C. further loss was inappreciable. Though the solid dyestuffs showed a slight change of shade on heating to 140° C., the 2% loss in weight was regained if the oven was cooled to 110° C., and the dyeing properties of the solutions were quite unaffected by heating the material to these temperatures. It was therefore concluded that no chemical decomposition had taken place, but that the dyestuffs were extremely hygroscopic in the same fashion as charcoal or cellulose, gaining or losing water continuously according to the humidity of the surrounding atmosphere, and not discontinuously like magnesium chloride and other crystalline salts. This was checked by measuring the absorption of moisture from controlled atmospheres at different humidities at the same temperature, and very high absorptions were found. Sky Blue FF, for instance, took up over 10% of its weight of water from an atmosphere at 20% R.H., and over 50% of its weight from saturated vapor.

It was concluded that most direct dyestuffs were extremely hygroscopic, that they could be dried with absolute certainty only by heating to about 100° C. in vacuo over phosphorous pentoxide, but that for practical purposes it was sufficient to heat to 110° C. in an oven, and allow 1% for moisture still retained. It is, of course, necessary to take every precaution against access of moisture during weighing of oven-dried dyestuffs.

Estimation of the Purity of Direct Cotton Dyestuffs

Various methods, none of them altogether satisfactory, are available for this purpose. For all azo dyestuffs Knecht and Hibbert's method, which depends on the quantitative reduction of azo groups to amino by the use of titanous chloride solution, may be employed. If adequate precautions are taken this method is capable of giving theoretical results on most dyestuffs in a pure condition, but on impure materials high results are as a rule obtained, owing to the reduction of substances other than the dyestuff by the very active titanous chloride. With Chrysophenine G, an azo color of the stilbene class, a titre substantially below the theoretical is obtained even with pure dyestuff.

The gravimetric estimation of sodium as sodium sulfate is a more useful check of the purity of a sample of dyestuff. The method is sensitive to the presence of inorganic impurities, since the sodium content of a pure dyestuff is relatively low and if a platinum crucible is used good results are obtained without difficulty. Isomers and homologues of the dyestuff are, of course, not revealed by this method or by the reduction method.

Comparative or relative methods may be very useful. They are employed to compare the purity of a dyestuff at successive stages of purification, or to compare differently purified samples of the same dyestuff, perhaps obtained from independent makers. If, using a critical comparative method, several quite independent samples of the same color appear to be identical, it is reasonable to presume that a state of purity has been attained. One such comparative test is the electrical conductivity of a solution of standard concentrations, which is very sensitive to the presence of extraneous electrolytes.

The "color value" of standard solutions, measured in a good colorimeter at a concentration of about ten milligrams per liter, is an even more useful comparative method. It detects the presence of isomers or homologues of different hue, and colorless impurities are also detected as they reduce the color intensity.

This test may be extended and made still more critical of colored impurities by comparing the hue of partially exhausted dyebaths with that of the original solution.

It will be observed that the absolute chemical methods are not very critical or selective, while the more critical physical methods can only be used for purposes of comparison. It is, therefore, not yet possible to state with positive certainty the absolute purity of any direct dyestuff. The decision as to whether a particular sample is sufficiently pure for a particular research purpose is still a matter of subjective judgment based on the results of various tests. The greater selectivity of the colorimetric as compared with the reduction method of analysis is illustrated by an actual example in the case of a sample of Benzopurpurine 4B taken from an early stage of the laboratory purification process. This gave an apparent purity of 96% against titanous chloride, while colorimetric comparison with the last stage showed a dye content of only 90%. It should perhaps be emphasized that the color intensity of the solutions was found to be uninfluenced by age, thermal history, or by the addition of salts. Of course, the presence of impurities in the dyestuff itself lowers the color intensity simply by reducing the amount of actual color in a given weight of material.

The Estimation of Direct Cotton Dyestuffs on the Fiber

This is a problem which has only recently been solved in a satisfactory manner. Optical methods are not applicable as a means of measuring dye content on account of the complications introduced by the irregular structure and surface of the dyed material. The chemical method of reduction by titanous chloride has been put forward by Knecht and Hibbert. This method is, however, by no means an easy one, though it can be made to give accurate results on relatively large samples of cotton dyed abnormally heavily. Since it demands an amount of dye of the order of one-tenth of a gram, it cannot be used on convenient samples (i.e., under one gram) of normally dyed material which usually contain from 0.1 to 2.0% of pure dyestuff. On dyed viscose the reduction method is more unsatisfactory than with cotton. End-points are more unreliable and discrepancies are common even when every possible precaution is taken to exclude air in both blank and dyestuff titrations and where a rigidly controlled procedure is followed.

A much simpler and more accurate method of estimating very small quantities of absorbed dyestuff has recently become available. This is based upon the observation of

Ratelade and Tschetvergov (Rev. Gen. des Mat. Col., 1928, *32*, 802) that pyridine so far prevents the absorption of direct dyes by cellulose that a mixture of pyridine and water constitutes a most effective stripping agent. A mixture containing one part of pyridine to three of water is convenient and effective, being capable of removing completely any direct dyestuff from any cotton or other cellulose material. As a rule a few hours' treatment at room temperature is sufficient, but in some cases it is necessary to heat to about 50° C. to remove the absorbed color completely.

Dyestuffs in the pyridine mixture retain their usual color almost unchanged and the solutions can therefore be analyzed by means of a colorimeter. It is, however, not advisable to heat the stripping solution too strongly, as at the boiling point in presence of cellulose and pyridine some of the dyestuff may be destroyed by reduction.

With normally dyed materials a sample weighing about ten or twenty milligrams will yield on extraction with several ccs. of the pyridine mixture, a solution of suitable concentration for colorimetric measurement.

In the colorimeter the solution obtained by stripping is compared with a standard made up from pure dye in the same solvent. For visual colorimetry a high grade instrument of the Duboscq type, in which two columns of liquid are viewed in a suitable field and the color matched by varying their depths, is quite satisfactory. If certain precautions are observed a result accurate within one per cent can be obtained with a good instrument. Each dyestuff should be tested for proportionality between color and concentration (Beer's Law) and the ratio of the concentrations in any comparison should not exceed 1.5. The optimum concentrations for most dyestuffs is from 0.01 to 0.03 grams per liter. Outside this range visual working is less accurate. Only instruments with the light source built in and totally enclosed are suitable for accurate work. With blue, green, red and violet dyestuffs sharp readings can be obtained using the unfiltered light from an opal lamp as the source. Some improvement may be obtained by the use of a light filter transmitting that portion of the spectrum which is most strongly absorbed by the dyestuff, but with the above colors the advantage is slight. When it is desired to measure a yellow or orange dyestuff, however, plain white light is not suitable. Daylight gives slightly better matching of these colors than does the light from an electric lamp, but is unreliable and cannot be enclosed. Fairly good matching of yellows and oranges can be obtained by using a dense violet filter, transmitting only the short wave end of the visible spectrum. The use of such a filter greatly reduces the amount of available light, so that a very intense source must be employed. The new Leitz instrument, in which the source is a low voltage focus bulb, in conjunction with a condensing lens instead of the usual diffusing screen, gives extremely powerful illumination which is sufficient for use with such a violet filter. Although with such an arrangement quite sharp settings can be obtained with yellow and orange dyes, the readings do not appear to be accurately reproducible over long periods, they differ from one observer to another, and considerable discrepancies are found on interchanging the solutions. These difficulties, which only arise when the violet light is being used on yellow or orange dyestuffs, seem to arise from some peculiarity in the human eye.

This leads to the question of photoelectric colorimeters. While superficially these appear to possess almost every advantage over the visual instruments, they are perhaps not yet suitable for general use. Photoelectric instruments are not at the time of writing available commercially at moderate cost, and their construction requires considerable time and skill. Many of the published designs are extremely complicated, though a fairly simple instrument has recently been described by Selwyn (J. Scient. Instruments, 1933, *10*, 116).

There can be no doubt, however, that the present stage of development will proceed rapidly, and that instruments of great accuracy and convenience in use will be generally available in a few years. With such an instrument and using the stripping technique described above, the estimation of absorbed dyestuff on cellulose materials will become a very simple and highly accurate procedure, even with the "pale" hues such as yellow and orange.

Summer Woolen Card

The 1934 Summer Woolen Card, comprising a special collection of ten new shades, has just been sent out by the Textile Color Card Association to its members. This supplementary woolen card, the first of its kind to be issued by the Association, constitutes an additional service to members.

The high fashion tendency toward faded or overcast shades is apparent in several important colors of the group. Dustblu, a muted tone of medium value, reflects the growing interest in greyed blues. Aztec Rust, a soft Indian pottery tone with a hint of rose, is a new variation of the popular Mexican theme. A smart expression of the same motif is Mexigold, a deep old gold. Completing the group of "off" shades is Honey Peach, a mellowed fruit tone.

Among the paler tints, Creampearl represents a new version of "off-white." Anisette, a refreshing pastel green, is the shade of the French liquer by that name. Tuscan Blue is a smart rendition of a "linen" blue tone. Another cool Summery hue is Dawnrose, a clear pink with depth.

Because of the marked interest in aquamarine and lemon yellow, Aquarelle and Lemontint respectively are two pastel tones which have repeated from the Spring Silk Card.

These new colors are intended for use not only by the woolen trade but by other textile and allied fashion industries as well, including millinery.

Steam

with Regard to Handle and Finish

By G. L. ATKINSON

STEAM is all-important in the textile trade, yet it is surprising even in this enlightened period, how very little attention is given to this subject by experienced employees and even the heads of various types of textile concerns. The subject has never been studied as much as it might have been, both with regard to the obtaining of the steam, and also the means of using it.

This is most surprising in view of the fact that the textile trade is wholly dependent upon steam for most of its dyeing and finishing processes.

There are five distinct and separate processes in which steam is used, that is in which the steam during the process has a vital effect upon the cloth from the point of view of the handle and finish obtained. Taking the processes in order, they are as follows: 1, crabbing; 2, dyeing; 3, drying; 4, decatizing; 5, steaming in finishing. All of these operations have a definite effect upon the cloth, yet this is not theoretically correct, as it is the steam used during the operation that has the effect upon the cloth and the result obtained depends upon the method in which the steam is used. Often the quality of steam and the manner of using it is just the difference between the success and failure of a textile dyeing and finishing concern.

The writer has noted several instances of firms who although equipped with the very latest machinery have been far from successful with their finished products. In addition the writer has noted several instances, of firms who were equipped with poor or out-of-date machinery, who nevertheless sent out far better goods with regard to dye, finish and handle, than firms who had very much superior machinery, simply because they paid the maximum amount of attention to their steam and the methods of using it during each of the five aforementioned processes. It is actually possible to turn out excellent results with regard to dye, finish and handle, with very crude tools or machinery, which goes to show how much can be obtained by attention to this all-important subject.

It is no new fact to state that the more steam that wool and woolen goods receive the better they are, yet the questions of whether the steam is suitable, or the methods by which it is used correct are scarcely ever studied by the employees, foremen or management.

In the first place all steam for use in the preparing, dyeing and finishing of textile fabrics should contain a good deal of water content. Some firms consider this a fault, but in actual fact it is far better for the steam to err on the wet side than be too dry, as is the case of superheated steam. This fact of the steam being wet or containing a good deal of water content should never be disregarded and dry or superheated steam should never be used in any textile dyeing and finishing operation.

The first operation, namely, crabbing relies for its success or failure from a cloth point of view almost entirely upon the steam and the method of using it. Crabbing is more or less, even today, an operation that is shrouded in mystery. In this operation steam is used in both the crab bowls and also in the steaming arrangement of the machine when the goods are steamed after having passed through the crab bowls. Often the goods when crabbed are thin and papery in handle, and the tension or pressure placed upon the goods when passing through the bowls of the crab is often blamed. This is often erroneous for when little tension is placed upon the goods, they are still thin and papery in handle when crabbed. This fault is often due to the fact that the steam used is too dry. This is rather remarkable when it is realized that the goods when revolving in the crab bowl are not in actual contact with the steam, but rather the steam in this case merely raises the temperature of the liquor in the crab bowl.

It often happens that cloths are not properly set during the crabbing operation, although the correct amount of tension is placed upon the goods. In this case the steam is blamed for containing too great a water content, thus causing the cloth to "cockle" or irregular "set" to take place. This is far from being the case, and is the result of improper methods being used with regard to the steam. It is a mistake to alter the supply of steam, making it drier, as this only results in the goods being thin and papery in handle.

It is possible for the steam to contain a terrific amount of water content and yet by correct steaming methods, obviate any "cockling" and obtain a perfectly even set of the fabric. This can be done by thoroughly boiling up the liquor in the crab bowl before the machine is put into

operation; the steam should then be shut off and the machine set in motion. When the goods are revolving round the crabbing roller in the bowl of the machine, the steam tap should be opened again and the goods allowed to revolve in the boiling liquor for at least a minute and a half. The commonest mistake, which causes bad set in crabbing, and which is often put down to the steam containing too great a water content, is that of boiling the liquor up while the goods are running into the crab bowl. In this case the goods are not under perfectly even tension, and the flow of the liquor is not even. These are the two factors which cause bad crabbing.

Steaming of the goods is generally attempted as a safeguard against "cracking" or "cockling" of the fabric occurring during the dyeing operation, this often happening with poplin and repp cloths if steaming is not carried out. The greatest danger in steaming is that of watering or embossing of the fabric, and many firms for this reason use dry steam for the steaming of the fabrics, in an effort to avoid this fault. They are of the opinion that steam holding a good deal of water content is the root and cause of the fault of watering developing in the goods. Although "cracking" and "cockling" are definitely guarded against, it cannot be said that dry steam is any safeguard against the fault of water marks occurring. In addition steaming of goods with moderately dry steam results in the fabric being very thin and papery in handle, and similar results are obtained by blowing the steam into the steaming can under too great a pressure because the effect when the goods are exposed to the actual steam free from water is too searching.

The advantages of steaming on the crabbing machine are appreciated to a much greater degree with crossbred goods than with botany, but in all cases no matter what the type of fabric, a very much softened handle is obtained than would be the case if the steaming operation was omitted. It has a definite softening effect upon the cloth, and the wool fibers of the cloth instead of being harsh and brittle become soft and full, giving a much softer handle when finally finished. It should be noted that during the steaming operation the wool is in the plastic state and also for some time after the operation. If there is little water content in the steam used, this results in the fibers being left dry, with the result that there is little or no amount of regain, and the only effect is that the fabric is thinner in handle. This effect cannot be obviated in any ensuing process, as the temperature obtained during the steaming of the goods on the crabbing machine is the peak temperature obtained throughout the works. In no other process is the wool in so plastic a state, and to obviate the thinness of the cloth it would be necessary to reach a still higher temperature than that of the steaming operation.

Blowing of the steam into the steaming can is also another fault that contributes to the goods being very thin in their final handle, this in addition also results in watering or embossing of the fabric taking place. The writer has noted cases of where the pressure of steam used for steaming was as high as forty pounds per sq. in., enough in some cases to blow the steam can to atoms. This difficulty can be easily overcome by fitting a steam reducing valve to the arrangement, by which no more than fifteen pounds per sq. in. can be used in steaming. In actual practice it will be found that nine pounds per sq. in. is a very satisfactory working pressure with which no faults occur, either with regard to thinness in handle or watering occurring in the goods.

The importance of the steam and the methods of using it during the initial crabbing and steaming of cloths, cannot be too greatly stressed, as the handle and finish of the cloth are determined during this process and not in the following finishing processes as is so often erroneously imagined. If a cloth is wrongly crabbed and steamed, it cannot be made right no matter what skill is exercised upon it during the final finishing processes. That is a fact that is not yet appreciated by many finishers and concerns. The finishing processes with all cloths merely assist the primary effects of crabbing and steaming. Even milling or stocking of an incorrectly crabbed or steamed piece cannot produce that full and soft handle which is obtained by correct crabbing and steaming in conjunction with suitable steam.

In dyeing, many responsible people in the trade argue that because the dyeing operation is responsible only for the coloring of the cloth, little or no attention may be paid to the kind of steam used. The writer has noted many instances of where the steam used in the dyehouse varied from practically superheated to steam that contained a great deal of moisture content. While the use of dry steam has little or no effect upon goods that have been correctly crabbed and steamed, it has a greater effect upon goods that have not been subjected to the steaming process. This includes such goods as face cloths, velours, heavy serges, etc., which owing to the type of finish desired upon the fabric cannot be subjected to the crabbing or steaming operations. Use of dry steam in the dyehouse should be discouraged at all costs, for the few pieces saved from cockling, etc., do not outweigh the goods that are spoiled with regard to finish and handle from the use of unsuitable steam.

In drying the same thing occurs, if the steam used is too hot, the fibers of the cloth are not allowed or encouraged to regain, with the result that the pieces become "baked," an effect which is appreciated in the harsh handling of the goods. Another effect which illustrates this point is found even when the cooling and conditioning arrangements of the drying machine are well nigh perfect, use of too high a temperature results in the humidity of the machine being seriously impaired, which again hinders the finish and handle of the cloth.

As far as the final finishing operations are concerned there are only two operations in which steam has an appreciable effect upon the cloth, that is in decatizing and in steaming. With the first named process, the question of the steam is all-important. If the steam used is too dry the beneficial effects of the operation are entirely lost. On the

other hand if the steam used is too wet or contains too great a moisture content, trouble ensues from cockled goods, owing to the blowing wrappers of the machine becoming wet through constant and incessant steaming operations.

The writer has noted one case where the decatizing machine was situated a good way from the source of supply, with the result that although all pipes were securely wrapped there was a great deal of condensation, which resulted in wet wrappers and cockled pieces. This was considered a bugbear, but in reality was a blessing in disguise, for although pieces were cockled and several other faults were noticeable, the pieces from the point of view of handle and finish were all that could be desired. Dryer steam was used to obviate the cockling but this led to complaints from customers that the handle of the pieces was too dry and harsh.

Finally the type of steam used at first was again put in operation but a drying can was fitted to the machine, over which the blowing wrapper passed. The drying can was never heated so that one could not bear one's hand on it for some considerable time. This resulted in the wrappers being dried sufficiently to just prevent cockling of the goods, yet the beneficial effect of the moisture laden steam was not lost and the pieces were all that could be desired in the matter of handle and finish.

In steaming the same thing occurs, yet nothing is more beneficial than the treating of wool goods with moisture laden steam. The writer has noted one case where the very fine finish achieved by a firm was greatly responsible for the careful steaming of the goods during finishing, both before and after pressing. Too much moisture in the steam during this operation admittedly often results in the cloth being water spotted and even glazed after pressing has been carried out, but this can be prevented by placing fine gauze or padding cotton between the piece and the steam supply.

It is an established fact that a firm which removes laying marks and creases in the goods by slowly and carefully steaming them, instead of running them over the dry tenter, achieves a much better result than firms who use the tenter for the removal of laying marks. This operation although of the simplest, well illustrates the benefits that accrue from the correct use of the proper type of steam, and it should never be omitted.

Addresses T. A. F. I.

"Fifty Years of Paraphenylene-diamine," a very timely topic, was the subject of an address by Florence E. Wall, F.A.I.C., as the guest speaker at the regular monthly meeting of the Technical Association of the Fur Industry, held at the Governor Clinton Hotel, New York on February 19th.

Miss Wall briefly reviewed its history, stressing the early errors that led to its regulation in certain European countries, and deplored the great amount of misinformation and incompetent opinion that has been disseminated in this country in the concerted efforts of professional reformers to ban paraphenylenediamine from the trade.

Miss Wall is well known in chemical circles as the former editor of "The Chemist", and as a technical consultant on cosmetics and beauty culture. She is the author of two standard textbooks and many articles. Her knowledge of the amino-dyes is well grounded, for she worked on them in 1918 at the Seydel Mfg. Co., Jersey City, N. J.; and gained invaluable clinical experience as educational director of Inecto, Inc., 1924-'28.

Discussion by Dr. Louis Schwartz, Public Health Service; Dr. Joseph B. Caspe, Pres. of the Assn.; William E. Austin, consultant to fur industry, and others.

North Carolina State Notes

A. R. Marley, a graduate of the North Carolina State College Textile School, who has been connected with the Erwin Mills Company at Cooleemee, has been transferred to Durham as Superintendent of the Erwin Mill No. 6. Mr. Marley is succeeded at Cooleemee by J. W. Inscoe, another alumnus of the same institution.

John R. Sherill, a graduate of the Textile School of North Carolina State College, who has been located at Elizabethton, Tenn., with the American Glanzstoff Company, has been transferred to North Carolina as salesman and will make his headquarters in Greensboro.

W. O. Hay, who has been with Wellington, Sears & Company in New York for a number of years, has been appointed Sales Manager of the Fine Goods Department of that organization. Mr. Hay is a graduate of the North Carolina State College Textile School.

Plurafil Colors

Under the name of Plurafil colors the General Dyestuff Corporation are offering a new line of dyestuffs, said to produce uniform shades on mixed fabrics which besides wool, silk, cotton or rayon contain also acetate silk. As goods of such construction are used more and more in the trade, these specially selected colors should be of great help to the dyer.

OPEN FORUM

You are invited to submit questions or to answer questions submitted.

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FOR DETAILS

PROCEEDINGS OF THE
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FEBRUARY 26, 1934

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Processing of Thrown Silk*

By G. W. SEARELL

Jacques Wolf & Co.

SILK throwing is the term applied to the several operations by which the raw silk thread is converted into yarn for the knitting or weaving trade. Both raw and thrown silk are bought and sold on specifications called Raw Silk Rules, which were devised by the Silk Association of America. These rules govern transactions between buyers and sellers in the United States of America and cover contracts, deliveries, weights, variation of size, seriplane inspection, and terms of sale.

Because of the hygroscopic qualities of raw silk and the uneven moisture conditions of the shipping points in the Orient, all raw silk is purchased on "conditioned weight" which is the absolute dry weight plus 11%. Thrown silk is sold on a "conditioned clean fiber" weight plus a regain of 11%. The United States Testing Company is the official conditioning house of the American Silk Association.

The term "clearance" is of vital importance to the buyer, manufacturer and seller of thrown silk. Clearance means the difference between the invoice weight of raw silk received and the weight of thrown silk delivered. It is sometimes erroneously believed to be the difference between the conditioned weight received and the thrown weight delivered and this interpretation has brought about very large clearances, some as high as 8% and 9% over the invoice weight. This excess clearance has brought an added task and expense to the throwster and the dyer since the throwster must use more soaking material and the dyer consumes more time in stripping, and often the stylist of the fabric receives a gross disappointment. High clearances mean an excess boil-off and when this yarn is woven the space which should have been occupied by silk is filled up by soaking material. A high boil-off also means short yardage. Some very interesting work was

*Paper presented before So. Central Section, Jan. 21, 1934.

done with yarns of various boil-offs by Irving Lewin of Duplan Silk Corporation and was published a few years ago. This table showed that a crepe yarn having the correct conditioned weight and a 25% boil-off gave the best yardage and best finished cloth. A high boil-off on hosiery tram means a lesser number of dozens produced.

Confidence in the throwster to return a legitimate amount of thrown silk with a 25% boil-off and constant yardage would certainly prove a boon to the silk industry in general.

Soluble silk oils give a much better resultant yarn than raw oils emulsified by soap because the former penetrate deeper, lubricate and soften. There has been developed recently an oil which requires only a small quantity to give a 25% boil-off and a legitimate clearance; it has proven very successful on six and eight thread 20/22 denier yarns and it leaves the silk immediately when it comes in contact with the boil-off bath, aiding that operation by acting as a wetting-out assistant.

On account of the unequal importance of the different clearness defects in the manufacturing and finishing processes and in their effect upon the quality of the finished goods, a set of inspection rules must be carefully followed by silk inspectors who are trained in that particular field.

The sizes of Japan raw silk used in the weaving trade and hosiery are 13/15 denier or an average of 14 deniers and 20/22 deniers or an average of 21 deniers. The yards per pound of a one-denier silk is 4,464,528 and by dividing this figure by the average denier size any yardage can be determined.

The foregoing gives some idea about the sale and purchase of the "Queen of Textiles" and shows how specialized that business is.

The throwing proper results in crepe, tram, grenadine or organzine twist. Crepe is thrown silk having 20 to 100 turns per inch, more or less for use in making crepes such as georgettes. Tram is a number of strands of raw silk soaked, doubled and twisted into a single thread. Organzine is a kind of thrown silk twisted like a rope with strands to increase its strength.

Grenadine

All hosiery previous to 1930 was made from tram which consisted of two or more ends of pure silk twisted from one turn per inch to eight turns per inch. A vogue of dull luster produced by wearing hosiery wrong side out invaded the hosiery field during the summer of 1929, and during the spring of 1930 hosiery with permanent dullness fabricated in the hose attracted considerable attention.

You will perhaps remember the Young Patent of the Westcott Hosiery Company of Dalton, Georgia, which described a knitted fabric in which the dullness feature was inherent in thread construction. This so-called grenadine twist, as stated in the patent, was made by giving each single end of silk a twist in one direction of 32 to 48 turns per inch. These ends were then all brought together and twisted again in the opposite direction 28 to 44 turns per inch. Thus to make four-thread grenadine 36/32, each of four ends was twisted separately 36 turns left, then the four were brought together and twisted 32 turns right.

Because of the added spinning operations the manufacture of this yarn was very expensive and it accentuated raw silk imperfections instead of eliminating them, as was thought would be the case, and therefore was abandoned.

This dull effect is now arrived at by chemical means with very little expense.

The various processes of hosiery yarn are:

1. Soaking.
2. Conditioning.
3. Winding.
4. First Time Spinning.
5. Second Time Spinning.
6. Setting of Twist.
7. Redrawing.
8. Coning.

To my mind the most important process is soaking. The raw silk as received in bales from the Orient is dry and brittle. To facilitate the various throwing operations and improve the quality of the ultimate finished fabric, it is necessary to soften and lubricate the fibers and the outer coating of gum or sericin. Emulsions of sulfonated oils, which are sometimes blended with raw animal and vegetable fats as well as mineral oil, are commonly used to accomplish the softening. During the last year a considerable amount of research work has been carried on for the purpose of determining the basic principles in regard to the soaking process and its effect upon the finished fabrics. The soluble oils used as a base for these soaking oils must be from pure non-drying animal or vegetable fats and sulfonation must be controlled absolutely to avoid dry yarns, oxidation, and rancidity. The blended oil must be so balanced that the throwster gets maximum efficiency of take-up and money value which in turn has a direct bearing on the thrown clearance. In order to get permanent softness and lubrication these oils must penetrate the fiber interstices and not just coat the outside surface of the gum.

The soaking operation consists of immersing the skeins in a bath of soluble oil and soft water at a temperature of 85-95° F., for twelve hours. This method is called tub soaking. Several ingenious machines are also in use which do the soaking in from one-half to two hours, thereby decreasing the inventory investment in the soaking department considerably. After soaking, the skeins are removed from the tub with care and hydro-extracted; then they are sent to the winding department.

Conditioning or seasoning to allow the soaked skeins to dry out partially is the next process. This process requires three to four hours before placing on the swift to be wound in order to avoid stretched yarn.

Winding is the process of transferring the soaked, conditioned silk from skein to bobbin or spool. It usually takes about four hours to wind a skein of Japan silk on to a bobbin. The tension on the swift must be carefully predetermined to avoid stretched silk.

It is a good practice to make seriplane panels of winding bobbins occasionally to check with the raw stock inspection in order to note the condition and catch any faults in the winding department.

First time spinning is really a doubling process where a small amount of twist is put into the several ends as they are drawn into one single continuous thread. The number of ends drawn into one gives the number of the thread, such as six-thread means six bobbins were drawn into one thread. The spindle speed of this operation varies from 4,000 to 6,500 according to the weight of endage, whether four-thread or 12-thread.

Second time spinning is the operation in which the finished number of turns per inch are put in. The bobbins from the first time operation are placed on the supply spindles and spun upward to a much slower speed than the supply which varies from 9,500 to 12,000 r.p.m.

The full take-up bobbins from this latter spinning are now placed in a steam chamber where the yarn is set or made lifeless on the bobbin. Next to soaking, this steaming is very important since the time, temperature, moisture, and position of the bobbins play a part which will mean success or failure of the yarn.

After the bobbins of twist set silk have dried sufficiently, they are redrawn through cleaners to take out waste and bunches and at the same time knotted with a weaver's knot to insure a continuous running yarn for the next operation.

The final operation previous to shipping is coning, where the yarn is placed on a package, usually a paper cone, suitable for knitting.

Silk Degumming*

By **A. HENRY GAEDE**

Laurel Soap Mfg. Co.

IN order to properly dye silk, and in order that it may be of commercial value, it is necessary to remove the silk gum from the fiber. This is accomplished by boiling the yarn or fabric in a solution of soap or soap-like products known as boil off oils. The process is known as degumming. In actual mill practice we are also concerned with the removal of the soap and oils added by the throwster.

The practical aspects of this paper will deal principally with the degumming of silk hosiery, since it is with hosiery that you of this section are concerned.

Any consideration of silk degumming should concern itself with the nature of the silk fiber. Silk, as it is produced by the silk worm, consists of two structural filaments cemented together by an amorphous glue-like substance—silk gum. The ordinary 13-15 denier silk of commerce is produced by twisting six or seven cocoon threads together and reeling into skeins. Silk varies in diameter. It is irregularly coated with gum and the filaments do not lie evenly side by side, but separate from one another and cross thruout the length of the cocoon thread. After degumming the fiber exhibits a much more regular and even appearance. Silk is the strongest and most elastic of textile fibers and when degummed is very lustrous. It is due to these physical characteristics that it has its commercial value and in processing the fiber, we wish to preserve these properties as far as possible.

In order to make some explanation of the theory of degumming it will be necessary to consider the chemical nature of silk. Chemically silk is composed of two proteins. The silk fiber or fibroin and the silk gum or sericin. These two proteins are similar in chemical constitution. Proteins, as a class, are the basic substance of all living matter and, from the chemical standpoint, they are complex condensation products of a group of organic compounds known as the amino acids. Amino acids are both

*Paper delivered before So. Central Section, Jan. 21, 1934..

acid and basic in nature. They contain a carboxyl (COOH) group and an amino (NH_2) group. These compounds combine with both acids and bases and they impart to silk its amphoteric nature which, for example, according to the chemical theory of dyeing, enables it to be dyed directly with both acid and basic colors. Most proteins dissolve in water, all hydrolyze with strong acids and strong alkalies. That is, a protein, silk for example, if treated with strong acids or alkalies decomposes into its constituent amino acids. It is for this reason we cannot use strong alkalies for degumming. With dilute acids and alkalies soluble ionizable salts are formed. With acids the amino (NH_2) group reacts, with alkalies the carboxyl (COOH) group. Since only agents which are mildly alkaline in solution are used for practical silk degumming, an investigation of the theory concerns itself only with the action of dilute alkalies on the proteins sericin and fibroin. Sericin is soluble in water, it is very sensitive to dilute alkalies, and it is amorphous and loosely held to the silk fiber. Fibroin is practically insoluble in water, it is not as sensitive to alkalies as sericin, and it is structural in form.

Sericin dissolves in the degumming bath and the carboxyl groups form a soluble salt with the alkali. It is for this reason we are able to separate it from the fibroin. An ideal degumming agent would be one which removed the sericin without attacking the silk fiber. Actually, the action is a selective one and all degumming agents have some effect on the fiber. For this reason, in order to get the best results, we must operate within rather narrow limits of alkalinity and not carry on the degumming for an unreasonable length of time. All the sericin does not react to form a salt. Some of it goes into colloidal solution and, possibly, some other form of reaction takes place between the protein and the alkali, but since the most chemically active groups attached to the protein molecule are the carboxyl and amino groups, it is reasonable to believe a good deal of salt formation takes place. That it does is shown by the drop in the pH of the degumming bath. All the hosiery dyers present know this occurs and there has been a great deal of discussion around the point. All degumming baths drop in alkalinity, they never increase or remain constant, but, as you also know, the degree of this drop depends on the alkalinity and amount of the degumming agent in solution. The salt formation is proven by electrometric measurement of the drop in pH which proteins show when they react with dilute alkalies. We may therefore conclude degumming of silk takes place because the carboxyl groups of part of the sericin react with the degumming agent to form soluble salts, that part of the sericin goes into colloidal solution; the fact that sericin is structureless and loosely held to the silk fiber helps these things to take place.

To illustrate the salt formation in silk degumming, I am going to use, as an example, the probable reaction between oleic acid soap and serine, one of the typical amino acids of silk gum. When oleic acid soap, sodium oleate, dissolves in water a certain amount of ionization takes place as follows:

$$C_{17}H_{33}COONa + HOH \longrightarrow NA^{+} + C_{17}H_{33}COO^{-} + H^{+} OH^{-}$$

Soap is made from a strong alkali and a weak fatty acid. Hydrolysis takes place with water resulting in the formation, in solution, of sodium hydroxide and free fatty acid. Some of the hydrogen ions of the water unite with the fatty acid ions to form molecules of fatty acid. This upsets the balance and more water ionizes resulting in more fatty acid formation. This continues until an equilibrium is reached, we then have sodium and hydroxyl ions or sodium hydroxide in solution. This is the reason a neutral soap is alkaline in solution. With other degumming agents the reaction is more complex, but this one is fundamental and illustrative of many of them.

Now let us introduce our amino acid, serine, into this system and allow it to react with the caustic soda formed by the hydrolysis of the soap:

$$CH_2OHCHNH_2COOH + NaOH \longrightarrow$$
(serine)
$$CH_2OHCHNH_2COONa + HOH$$
(Serine salt)

The COOH group of the amino acid reacts with sodium hydroxide, the terminal hydrogen being replaced by the sodium to form the soluble salt. Of course, this is shown merely as an example and nothing so simple happens in the complicated system we have in a silk degumming bath. It does, however, serve to show a reaction which is typical of those that take place. Throughout the degumming, the hydrolysis of the degumming agent takes place continuously and, as the sericin dissolves, some of the caustic soda is used up in forming the amino acid salt with the resulting drop in pH of the bath. The sericin salt also acts as a buffer. I have used, in the interest of simplicity, a monocarboxylic acid as an example. Experimental evidence indicates the terminal grouping of protein molecules are dicarboxylic acids, that is those containing two COOH groups.

This explanation has left out any consideration of the oils and soap used in silk throwing. This was done purposely in order to avoid complicating this already too complicated discussion. The soaps and oils used by the throwster dissolve or emulsify in the degumming bath, depending on their nature.

The whole subject of the reaction of textile proteins in alkaline or acid solution is a fruitful field for the research chemist.

Virtually all silk hosiery is degummed in the mill with neutral, low titer soaps or prepared products known as boil off oils. By experience the hosiery dyer has learned that these are the proper products to use. Good practice eliminates the use of high titer soaps and strong alkalies.

High titer soaps are difficult to dissolve and rinse out, they also dissociate to a greater extent than the low titer soaps. Strong alkalies attack the silk fiber itself and, although they have been used in some special cases, under careful supervision, in the degumming of skein silk, we all know they are dangerous. They have no place in hosiery degumming.

Good soft water, as nearly neutral as possible, should be used for processing silk at any stage in its manufacture and it is particularly important that soft water be used for degumming. The troubles resulting from the use of hard water are well known and will not be gone into here. Any hardness is liable to cause some difficulties. In my opinion water of over five grains hardness should not be used. There are many products recommended for use in the processing baths to correct hardness; there are some degumming agents which are said not to break down as readily as others in hard water. These products undoubtedly have some merit, but they are only palliative; for efficient and economical results a supply of soft water is necessary.

There are three methods of silk hosiery degumming and dyeing in use today. They are the two bath method, the one bath method, and a variation of the one bath method known as the split bath method.

In the two bath method the hosiery is degummed first, rinsed, and then dyed in a fresh bath. Ordinarily about 15% of 88% Olive Oil Soap or 8% to 14% of boil off oil, depending on the type of oil, is used. The bath is made up with the degumming agent, brought to the boil, the goods entered and run for one hour. The amount of soap or oil used will vary somewhat due to the nature of the water and the type of oil used in throwing. If the water possesses some hardness or mineral oils are used by the throwster, naturally, somewhat more soap or oil will be required. The dyer should use an excess of degumming agent to take care of variations in the gum content of the silk and differences in throwing oils. It is impossible to work on a theoretical minimum due to these variations. Afterwards degumming water is run into the batch and it is flooded over. This washes any scum and suspended dirt out the top. If the bath is dropped the stockings may act as a filter and part of the dirt adhere to the fabric. Two lukewarm rinses are generally sufficient to remove any soap or oil. The speed of the machine should be carefully regulated. If it runs too fast the hosiery will become tangled and knotted; the fibers are liable to be split and chafe marks caused. It is good practice to shake and rebag the hosiery before dyeing.

In the one bath method the proper amount of degumming agent is put into the bath, the temperature is brought to about 140 degrees, the goods are entered and run for about five minutes, so they may be wet out. The dyes are then added and the temperature raised to the boil. The dyeing operation is carried out as usual. In some cases the goods are entered at the boil, then the dyestuff added. Occasionally we will find that the dyestuff is added to the bath along with the degumming agent and the goods entered into the dyebath at the boil. It is my opinion that in the one bath method best results can be obtained by using the procedure first described. There are few advantages that can be claimed for starting at the boil and good practice would certainly indicate that the material should be wet out before the dyestuff is added. In describing these methods, I am attempting to give what I consider the best procedure and ones that are in actual use. Technically, this paper is not concerned with dyeing, but dyeing is so closely connected with degumming in the one bath method, we cannot ignore it. In actual practice considerable difference of procedure will be found, particularly in the matters of time and temperature. After the dyeing operation is completed, the bath is flooded over and the goods rinsed.

In the split bath method about one-half the necessary amount of degumming material is added to the bath and it is brought to the boil. The material is entered and run for fifteen minutes. The machine is run over for a few minutes, the bath dropped, and a new bath made up. The remainder of the degumming agent is added, the bath is raised to the necessary temperature and the dyestuff added. By this method the goods receive a preliminary scour which removes the throwster's tints and oils, and softens the gum. Thus, these foreign materials are not present during the dyeing operation. After dyeing the bath is flooded over and the goods rinsed as usual.

Olive oil soap or good boil off oils may be used in any of these three methods. Boil off oils in which sodium silicate is used as the alkali have been under fire recently and their use in the one bath or split bath method is questionable. They, in combination with silk gum, in monel metal machines, appear to have a reducing action on the ordinary silk blacks used by the hosiery dyer and render the matching of shades somewhat more difficult. Actually, they are in use in some plants.

Having left the theoretical side of degumming far behind, we are now upon the controversy with which the practical dyer is most concerned and about which he has been bombarded with all sorts of arguments. Which of the three methods shall he use? What degumming agent soap or oil? If an oil, which type? Which degumming agent in which method?

As my friend, Tommy Sledge would put it the answer is yes and no. Once again, in the textile industry, it is the condition, not the theory that confronts us. And the practical condition is that good work is being produced by all three methods and by using reliable boil off oils or olive oil soap in any of the methods. I have listened to many arguments and read many articles concerning this controversy; and I have reached the conclusion that the

practical conditions in each plant are those which must determine the method and whether soap or boil off oils should be used. Hosiery is being produced by the different methods and by using the different degumming agents that the experienced hosiery man cannot tell apart, to say nothing of the ultimate consumer. The actual plant working conditions, the practical considerations involved far outweigh all the theoretical arguments which may be advanced as to dissociation, drop in pH and relative alkalinity. A good case can be built in the laboratory for any of the methods and for soap or several different type oils. How they work under your conditions must determine the answer as to which method or what degumming agent you shall use. Not that the theories as to the action of the different products or methods should be disregarded. They should be carefully taken into account and considered in relation to the practical working conditions which limit you. Do not misunderstand me, different types of degumming agents do have a different effect. Different methods of applying dyestuff do produce different results as to fastness and clarity of shade. But, in the case of hosiery, from a practical viewpoint, the differences are generally small. Only by observation and a balancing of all the factors can the best method be determined for a given case.

Earlier in this paper I stated that the action of alkalies on textile fibers might be a fruitful field for investigation for the research chemist. The different methods of degumming and the action of the various degumming agents on the silk fiber and fabric are a fruitful field for the mill chemist. Nearly all investigation in this line has been done by people manufacturing soaps and oils or by those who develop or believe they have developed new products or methods. All these people have an axe to grind; the former something to sell, the latter a pet idea or theory to defend. The mill chemist, by investigating the various products and theories in relation to practical working conditions, can clear up many disputed points.

Although they are probably well known to most of you, I wish to discuss briefly some of the advantages claimed for the different methods of degumming which have been advanced to me on my wanderings thru this section. They are being presented, and some of them answered, with the thought that they might be of interest to you—my position is neutral.

In the two bath method it is claimed that better and cleaner dyeings are produced because all the gum, dirt, and throwing oils have been removed previous to dyeing. Its advocates claim it is certainly better practice to dye the fabric after it has been thoroughly cleansed and all foreign matter removed. This argument is sound. It is also claimed that less dyestuff is required, clearer and faster shades produced, because the dyeing is not carried out in a medium of soap or alkaline oil. Somewhat less dyestuff is required in the two bath method, but from a practical standpoint, very little difference in cost will result, because the light shades now in vogue require very small amounts of dyestuff under any method. If other advantages are gained by using the one bath method, the saving in dyestuff cuts a small figure. The matter of clearer and faster shades is debatable. Shade matching is claimed to be easier because of the absence of interfering chemicals.

The advocates of the one bath method claim that the condition of the silk fiber and fabric is much better, due to the shorter time required for processing and because the silk gum acts as a protective agent; that saving in time and steam far outweigh the additional cost of dyestuffs; that shades will check better because the alkaline medium will take care of water variation; that a better finish is produced. In answer to these arguments, it is certainly true that silk should not receive too long or harsh treatment, however, it is a strong fiber and your hosiery will not suffer greatly in quality if the two bath method is used. Often a given run receives longer and harder treatment in a dyehouse using the one bath method than the average run in the two bath dyehouse. The economic arguments cut a small figure. The difference between the various methods is small if a mill is equipped to handle the method it is using. For example, if a dyehouse using the two bath method has a large machine in which it can degum sufficient hosiery at one time to take care of its dyeing capacity, certainly there is small saving in time between the two methods, figured on a basis of total production. Certainly, an efficient dyer wishes to operate as cheaply as possible, but any improvement in the finished fabric is more important than savings in degumming and dyeing which amount to a small fraction of a cent per dozen. The argument that shades check more accurately is questionable and the reason fallacious. Shades dyed by one method probably check about as well as those dyed by another. After all, the dyer and the dyestuff are the main actors here. What advantage exists is with the two bath method. The idea that a better finish is produced in the one bath method all depends on the finish you want. Today nearly all silk hosiery is given a separate finishing treatment after dyeing and you can produce just about any finish desired, irrespective of the degumming and dyeing method.

The split bath method claims all the advantages of the one bath method and none of the disadvantages. It has its points, but we finally come back to our original proposition: the set up of the dyehouse and practical considerations in your plant must govern the method you select.

Finally, I would like to mention some of the different types of degumming agents in use today. Olive oil soap has been proven by long use to be one of the best. It is the time honored degumming agent, and when used under conditions to which it is adapted, it is, from both the chemical and practical standpoint, at least as good as any

other degumming agent. This applies to both soda and potash soaps. The soda soap is somewhat easier to handle and contains less free alkali. The potash soap is slightly more soluble and contains the glycerine resulting from its manufacture.

To discuss all the types of boil off oils would take too long. The most common types in use today I have classified roughly as follows:

The Silicated Type in which the alkali used is sodium silicate. They are usually made from sulfonated castor oils which are prepared so the silicate will combine and not settle out.

The Sulfonated Oil type in which a sulfonated oil is brought to a definite alkalinity by the addition of caustic alkalies or carbonates so it may be used for degumming.

The Cresylic Acid Type in which cresylic acid is combined with either sulfonated oleic acid or sulfonated castor oil or a combination of the two oils.

The Solvent Type in which organic solvents are used in combination with either saponified or sulfonated oils.

This classification is very rough and oils are made which do not fit into any of the classes or which overlap and fall partly in one and partly in another, however it represents the main types.

In most boil off oils, oleic acid, either sulfonated or saponified or sulfonated castor is used. Generally speaking caustic soda or soda ash is the alkali used, although in some, particularly the heavier oleic acid boil off oils or those of the solvent type, caustic potash or pearl ash is used.

The main arguments in favor of boil off oils is the ease with which they may be handled and the fact that with some a lower percentage may be used for degumming. Each type of degumming agent has its peculiar properties and once again it is the practical conditions which determine your choice.

NINETY-SECOND COUNCIL MEETING

THE Ninety-second Council Meeting of the American Association of Textile Chemists and Colorists was held at the Chemists' Club, New York, N. Y., December 8, 1933, at 1:45 P. M.

The following were present:

President: R. E. Rose.

Vice-Presidents: Wm. H. Cady, Alex. Morrison.

Treasurer: Wm. R. Moorhouse.

Councilors: Wm. D. Appel, Hugh Christison, Carl Z. Draves, Walter M. Scott.

Councilors ex-Officio: Roland E. Derby, Hans Meyer, L. A. Olney.

Secretary: A. Newton Graves.

The minutes of the last meeting were read and approved.

The Secretary's balance sheet was read as follows and approved:

Secretary's Balance Sheet—Dec. 7, 1933

Cash on hand, Oct. 26, 1933			$593.37
Receipts, Oct. 26, to Dec. 7, inclusive:			
Applications	20 @	5.00	100.00
Applications	1 @	2.50	2.50
Dues	440 @	5.00	2,200.00
Dues	2 @	2.50	5.00
Dues (Arrears)	1 @	2.50	2.50
Dues (Corporate)			1,400.00
Dues (Sustaining)	13 @	10.00	130.00
Rebate from Year Book			72.54
Reporters, Howes Publishing Co.			6.25
Year Books, 3 @		2.00	6.00
Year Books, 3 @		3.00	9.00
			$4,527.16
Disbursements:			
To Treasurer, Dec. 4, General Fund			$1,300.00
To Treasurer, Dec. 4, Research Fund			700.00
To Treasurer, Dec. 5, General Fund			300.00
To Treasurer, Dec. 5, Research Fund			700.00
Government tax on checks			.02
Cash on hand, National Bank of Commerce & Trust Co.			1,527.14
			$4,527.16

The Treasurer's report was read as follows and approved:

Treasurer's Report—Dec. 7, 1933

General Fund

Cash on hand—November 1, 1933	$7,396.62
Receipts—Nov. 1, 1933, to Dec. 7, 1933	1,600.00
	$8,996.62
Expenditures—Nov. 1, 1933, to Dec. 7, 1933	$1,756.42
	$7,240.20

Research Fund

Cash on hand—November 1, 1933	$1,617.98
Receipts—Nov. 1, 1933, to Dec. 7, 1933	1,400.00
	$3,017.98
Expenditures—Nov. 1, 1933, to Dec. 7, 1933	$909.70
	$2,108.28

Bank Balance

General Fund	$7,240.20
Research Fund	2,108.28
	$9,348.48
First National Bank—Checking Account	$3,812.05
First National Bank—Savings Account*	5,536.43
	$9,348.48

*$1,000.00 transferred from Savings to Checking Account on Dec. 1, 1933.

The following were elected to membership as of thirty days after the publication of their names provided no objections to any are received by the Secretary:

Active

Balloch, James—971 Harrison St., Philadelphia, Pa. Dyer, Delta Finishing Co., Lewis and Ashland Sts.

Bragg, Harrie P.—39 Madison Ave., Mt. Holly, N. J. Dyer, Beaunit Mills, Inc., Beverly, N. J.

Corbett, James F.—207 W. Union Ave., Bound Brook, N. J. Chemist, Calco Chemical Co.

Cowan, Robert—2304 Laurel Ave., Knoxville, Tenn. Chemical Engineer and Salesman, Quaker City Chemical Co.

Curtil, Maurice—Roemer Store, Cresaptown, Md. Dyer, Celanese Corp. of America, Cumberland, Md.

Murphy, John James—21 Vista Ave., Medford, Mass. Textile Chemist, United Aniline Co., 156 Pearl St., Boston, Mass.

Neville, Harvey A.—1747 Union Blvd., Bethlehem, Pa. Associate Professor of Chemistry, Lehigh University.

O'Neill, J. H.—Y.M.C.A., Columbus, Ga. Overseer of Dyeing, Eagle & Phenix Mills.

Pragmen, Johan E.—Abbott Court North, Radburn, Fair Lawn, N. J. Asst. Superintendent of Dyehouse, Imhoff-Berg Silk Dyeing Co., 180 E. 7th St., Paterson, N. J.

Reincke, Albert H.—4633 Horrocks St., Frankford, Philadelphia, Pa. Overseer of Dyeing, Continental Mills, Inc., Germantown, Philadelphia, Pa.

Schmidt, Edward H.—510 Fulton St., Elizabeth, N. J. Chemist, Borne, Scrymser Co., 632 S. Front St.

Schwarz, Edward R.—63 Lovell Road, Melrose Highlands, Mass. Asst. Professor of Textile Technology, M.I.T., Cambridge, Mass.

Junior

Delk, Lucius—Bleachery, Clearwater, S. C. Second-hand of Bleach-house.

Fancourt, Walter F., 3rd.—622 E. Leverington Ave., Roxborough, Philadelphia, Pa. Salesman, W. F. Fancourt & Co., 516 S. Delaware Ave., Philadelphia, Pa.

Hart, Thomas H.—4927 N. Tenth St., Philadelphia, Pa. Chemist, Kane Mfg. Co., Delaware Ave. and Morris St.

Jackson, E. C.—Dormitory, Lyman, S. C. Chemist, Pacific Mills.

Zametkin, Robert—1067—80th St., Brooklyn, N. Y. Chemist, Pilgrim Piece Dye Works, Inc., 1 Nassau Ave.

Student

Garner, John W.—Kezar Falls, Maine. Student, Lowell Textile Institute, Lowell, Mass.

Associate

Baker, Pearce H.—362 Mills Ave., Spartanburg, S. C. Lubrication Engineer, The Texas Co.

Harris, Jay C.—2695 Boulevard, Apt. 27, Jersey City, N. J. Research Chemist, Colegate-Palmolive-Peet Co., 105 Hudson St.

Royce, Irving J.—814 Central Ave., Charlotte, N. C. Salesman, Royce Chemical Co., Carlton Hill, N. J.

Carl Z. Draves read the report of the prize committee. It was voted that the list of "honorary mention" papers be published. It was also voted to award the following prizes for papers published in the Proceedings:

First prize	$50.00
Second prize	25.00
Third prize	15.00
Fourth prize	10.00

It was voted to hold four Council meetings between this meeting and summer, the first to be held on the fourth Friday in January, in Providence, R. I.

Adjourned.

Respectfully submitted,

A. Newton Graves,
Secretary

NINETY-THIRD COUNCIL MEETING

THE Council held its ninety-third meeting on January 26th in the rooms of the Providence Engineering Society. Vice-President Alex. Morrison called the meeting to order at 2 P. M. Also present were: William R. Moorhouse, Treasurer; Louis A. Olney, Chairman of Research Committee; Walter M. Scott, Carl Z. Draves, Hugh Christison, and Donald H. Powers, Councilors-at-Large; Heyward F. Lawton, representing Rhode Island; Hans Meyer, representing New York, and Harold C. Chapin, Secretary.

Regrets were received from Robert E. Rose, and A. R. Thompson, Jr.

Secretary Graves' minutes of the ninety-second meeting were read and approved.

The Secretary's report on receipts for the current fiscal year, November 1 through January 25, read and approved, appears on the following page.

The Treasurer's report, read and accepted, was as follows:

Treasurer's Report

January 26, 1934

General Fund

Cash on hand—December 7, 1933	$7,240.20
Receipts—December 7, 1933, to January 26, 1934	991.36
Receipts—January 25, 1934—Final check from A. N. Graves closing out his account	1,397.08
	$9,628.64

Expenditures—December 7, 1933, to January 26, 1934	$520.71
Balance—January 26, 1934	$9,107.93

Research Fund

Cash on hand—December 7, 1933	$2,108.28
Receipts—December 7, 1933, to January 26, 1934	2,250.00
Receipts—January 25, 1934—Final check from A. N. Graves closing out his account	130.00
	$4,488.28
Expenditures—December 7, 1933, to January 26, 1934	$905.96
Balance—January 26, 1934	$3,582.32

Bank Balance—January 26, 1934

General Fund	$9,107.93
Research Fund	3,582.32
	$12,690.25
First National Bank—Checking Account	$7,153.82
First National Bank—Savings Account	5,536.43
	$12,690.25

Respectfully submitted,

W. R. Moorhouse,
Treasurer

Each of the following was elected to the class of membership specified, as of thirty days from publication of application, provided no objection be received meanwhile by the Secretary:

Active

Bozetech C. Bren
Paul Delmonico
Franklin C. Dexter
A. Winston Edwards
John H. Egli
Milton K. Emerson
David Himmelfarb
C. Clifton Kerns
Samuel Lenher
James E. Loughlin
Witold Olpinski
Herbert Seyferth
Sidney L. Wheaton

Junior

J. H. Ciciva
Peter Spence Gilchrist, Jr.
John Smith
W. H. Moon
Samuel G. Newman

Associate

James A. Carson

It was voted that a committee be appointed by the President, to make recommendations, at the June meeting of the Council, on the membership qualifications in the Constitution of the Association.

A letter from the President was presented, opening discussion of the relation of the Association, in conduct of research, to the Bureau of Standards, Textile Foundation, and other bodies. It was voted that the President appoint a committee of three to study the research work of the Association, and to recommend a concrete plan for assisting the Chairman of the Research Committee in the future coordination of the research work, and to recommend a plan for allotment of appropriations for research projects, in collaboration with the Treasurer and the Chairman of the Research Committee. It was further voted that this committee be requested to report to the Council at its meeting in New York this spring.

Thanks were voted the Providence Engineering Society for use of its rooms.

The meeting was then adjourned, and followed by a meeting of the Research Committee.

Respectfully submitted,

Harold C. Chapin,
Secretary

Secretary's Balance Sheet

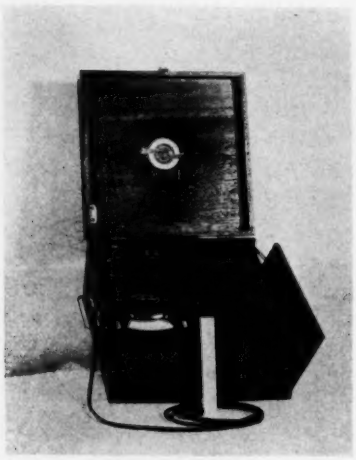
	Applications	Dues, Regular and Re-instate.	Sustaining Dues and Contributions	Corporate Dues	Misc.	Totals
Received by Secretary Graves and transmitted to Treasurer	$102.50	$2,212.50	$125.00	$1,400.00	$93.79	$3,933.79
Received by present Secretary (a)	75.00	1,403.86	95.00	100.00	14.85	1,688.71
Total receipts for fiscal year through Jan. 25	177.50	3,616.36	220.00	1,500.00	108.64	5,622.50
Transmitted by present Secretary (b) to Treasurer	35.00	881.36	75.00	100.00		1,091.36
Leaving to order of Secretary in Appleton Bank of Lowell, (a-b)	40.00	522.50	20.00	0.00	14.85	597.35

MEETING, RHODE ISLAND SECTION

"Demonstration of the Telecolor Machine"

By C. Earl Hays*

AT A meeting held at the Providence Engineering Society, Friday, November 24, 1933, under the auspices of the American Association of Textile Chemists and Colorists, C. Earl Hays of Pawtucket, R. I., gave a lecture on a most ingenious manner of reading color values in dyed, coated or liquid materials.



The Telecolor Machine

During the lecture Mr. Hays demonstrated a recent invention of his, the Telecolor, a color matching device. Taking two samples which did not match satisfactorily, he charted the different values of the component colors of a combination of colors by making a spectro-analysis and showing the variations of color at different positions along the visible spectrum.

In describing the position of the visible spectrum in the etherial spectrum, the speaker drew a chart, similar to the one shown on the next page, on a blackboard of the entire etherial spectrum and explained each section in detail. Starting at the radio telegraph band he showed the various sections including the broadcast radio, short waves, Hertzian waves, solar, heat, infra-red, visible, ultra-violet, X-rays, gamma and cosmic rays. He then selected that portion covering the visible range and described how each color had a definite wave length which he was able to read with hisdevice. These measurements were demonstrated and checked by the apparatus used during the lecture.

The Telecolor device is a small box-like affair using photo-electric cells, often spoken of as "electric eyes" and included an instrument with a graduated scale. Two samples, which to the human eye appeared to be of exactly the same color were placed in two compartments. By pressing a button the instrument instantly indicated which of the two samples was the lighter in color. He explained the method he uses to test coated paper or to check their opacity; or to check the color values of liquids such as paint or dyes. The device was also used to test various types of glass for the transmission of light.

We read in our trade journals of an electric eye being used for this or that purpose and its use appears to us as being of a phenomenal nature. The speaker briefly outlined some of the different types and explained the manner in which they are used.

The phenomenon of photo-electric effects was first observed in the year 1887 by Hertz but it has been only in the past ten or fifteen years that we have been able to control and use their enregy. Generally speaking, there are five different types, the gas filled, vacuum, dry plate, electrolytic and selenium cells. These cells are formed into many different shapes suited to the purpose for which they are to be used but generally they are of the same size and shape as a modern radio tube or like an open faced watch.

The gas filled and vacuum types are glass containers, either filled with one of many different kinds of gas or evacuated. The dry plate type which is shaped like an open faced watch is just a sensitized plate with a collector ring. The electrolytic type is a glass container filled with a liquid solution. The selenium cell is a coated element within a glass container.

All of the above types have two electrodes within the unit for the purpose of creating or conducting the energy, with the exception of selenium cell. This latter type is different from the others. It is a type where external energy is a part of the circuit and the selenium cell changes its resistance when subjected to light rays. All of the others generate their own energy when subjected to light rays. In the gas filled and the vacuum types the energy generated is so small that some means of amplification must be employed while in the dry plate and electrolytic types the amount of energy generated is sufficient to use with special relay equipment.

The amount of energy emitted from the photo-cell is directly proportional to the amount of light directed on it. This now brings us into the field of color, for we know from scientific research that each different color absorbs so much light and reflects the difference. From this we can readily see that a photo-cell subjected to a certain amount of light energy would respond, equivalent to the amount of reflected light and if the color of the reflecting agent were changed the amount of energy emitted by the photo-cell would correspondingly change. This same condition takes place when our eyes view colors, only that the sensations on our brain cells change and tell us the color reflected by an object. As the photo-cell responds to the spectral wave lengths in much the same manner as the human eye, it has been called the "electric eye."

For industrial uses the gas filled and the vacuum types are most generally used. The specific use would govern the type of gas to be used or the degree of vacuum. Special gases such as helium, neon, argon and other rare

*Mr. Hays, who is an electrical engineer, has spent many years working with light sensitive devices. For more than ten years he was associated with different branches of the American Telephone & Telegraph Co., the last of which was on the staff of the chief installation engineer of the Western Electric Co., in New York.

gases of the atmosphere are used depending on the application of the photo-cell to the work required of it. The electrolytic type, being filled with a liquid solution, is only adaptable to operations where there is a minimum of vibration and although these cells are quite sensitive and emit a comparatively large flow of current when exposed to light, they should not be subjected to too great an amount of light energy as this will destroy their sensitivity. The dry plate type is quite as sensitive and will emit as much if not more than the electrolytic type and its sensitivity is not affected should it be exposed to a high intensity of light. As explained before, the selenium cell differs from the others in many respects but for many years this type was used in the transmission of pictures by telegraph, such as telephoto work.

In industrial work the uses of photo-cells appear to be unlimited. They are being used for counting, inspecting, sorting, opening doors, controlling titration of water, floor selection for elevators, burglar alarms, turning on and off lights, operating drinking fountains, breakages in fabrics or paper, color control for printing and other uses too numerous to mention.

From these more or less crude uses the photo-cell has been introduced into the laboratories for many more refined uses. Time will not permit going as far into this subject as might be desired but a few practical demonstrations of the various uses of the photo-electric cell, including the use of the Telecolor machine, a device for matching the size, shape, finish or transmission properties of articles or materials will illustrate some of the various applications. It has been found that photo-cells are especially helpful in the field of color as was explained and demonstrated by Mr. Hays' device.

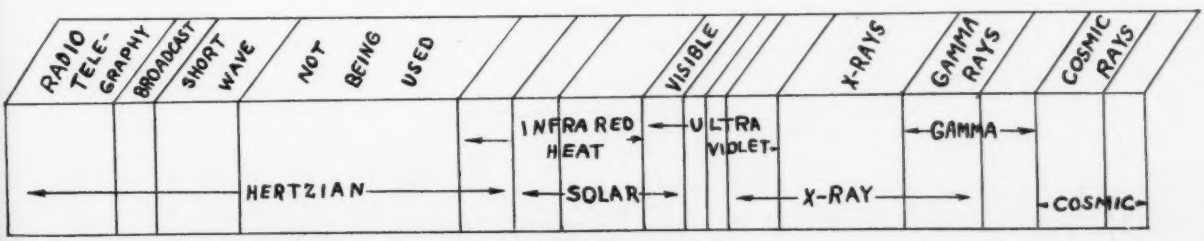
The speaker introduced a number of samples of cloth which he explained would be tested on the Telecolor for comparison after which he would break them down into their components, with the aid of color filters, to find out at what points on the spectrum the greatest difference would appear. At this point in his talk he explained the operation of his device, calling attention to two light chambers where the samples were placed. He then explained the method he uses to analyze colors. The two samples of blue broadcloth which he placed in the two compartments indicated that one was 29 points lighter in color than the other. After this many different samples were submitted to the meeting for visual comparison and then placed in the device. Two shades of another blue were placed in the device and showed a 7-point difference, then two greens which showed 15 points difference and various other colors.

A very interesting test was then made in which two samples of yellow were presented to the members and they were asked for an opinion as to which of the two was the lighter in shade. Contrary to the opinion of several of the group, the one sample which had been selected as the lighter was proven to be the darker. The speaker explained that this was due to the typing of the dye of one being blue which gave a green cast while the other had been typed with a red giving an orange cast.

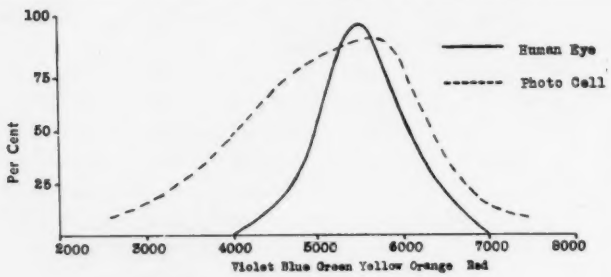
Mr. Hays told of one experience he had recently when he ordered some blue, supposedly a self-color, to make some checks on percentages. The chemist who has been working with him made some dyeings and the percentages worked out to his satisfaction but in making a spectro-analysis, he could not make the two samples check. After a little research work it was found that the dyestuff material had been typed with a certain red which had grabbed on one sample but did not have the same effect on the other sample.

Several of the members of the organization had furnished samples for Mr. Hays to check on his device. Some were of different formulæ while others were of the same formulæ but different percentages. He made these tests and plotted the spectro-analysis chart on the blackboard, showing all of the details of the different pieces of cloth which had been submitted to him. In conjunction with these tests he displayed some commercial work which he had done for some textile and paper mills in New England. His demonstration of the different values of light passing through window glass and his method of excluding infra-red light rays was most interesting, as was his demonstration of his test for percentages of bleaching and testing of the dye liquor for color before any actual dyeings were made.

Mr. Hays explained that his device was not meant to be a "cure-all" for the dyeing or textile industry, but merely meant as a tool to assist our eyes, especially during times of eye fatigue or on gloomy days. Unlike the human eye, this device is not subject to any eye fatigue, suffers no degree of color blindness or optical illusions,



The Etherial Spectrum



Comparison of Eye and Photo Cell

is not influenced by surrounding colors of objects and can be depended on to give the same results at any time of the day or night. One most valuable feature of this device is that in which a color can be broken down to tell just where any difference in two samples occurs. As far as the device itself is concerned, there is very little in the way of apparatus to get out of order.

The Telecolor has been tested out in several different textile and paper mills. All who have tried it agree upon its accuracy, simplicity and speed of operation.

The industries mentioned as beneficiaries of this invention were numerous, as it was useful to any industry where color, shape or size played a part.

NOTICE TO JUNIOR MEMBERS

JUNIOR members considering themselves qualified for Active membership, should write the Secretary immediately, in order that the Council may act upon their names in time for proper classification in the Year Book.

The Constitution states that, "Active membership shall consist of persons who shall be not less than twenty-six years of age, and shall have had at least five years' experience as textile chemists or as chemists otherwise directly concerned with the application of dyestuffs, dyers, bleachers, or finishers.

AMERICAN
DYESTUFF
REPORTER

LOUIS A. OLNEY, Sc.D.
Professor of Chemistry and Dyeing, Lowell Textile Institute
Directing Editor

NORMAN A. JOHNSON
Managing Editor

MYRON DREW REESER
Advertising Manager

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AN OPEN FORUM

MANY textile publications, the REPORTER among them, have from time to time conducted question and answer departments.

The REPORTER discontinued this practice some years ago for various reasons, among which might be mentioned the following:

1. Questions which were submitted for answer often were not subject to intelligent reply except after the expenditure of time and money in investigation which made such a course prohibitively expensive.

2. When intelligent answers were printed or published, the REPORTER was oftentimes criticized by subscribers who conducted laboratories, on the ground that we were offering a free service which tended to harm their own business.

3. Published answers were often criticized as being inaccurate or prejudiced.

4. Questions submitted were frequently of the "foolish question" variety.

These and other objections seemed to the Editor to outweigh the advantages of the Question and Answer Department and it was accordingly discontinued.

A questionnaire submitted to readers a few months ago, however, showed that the Question and Answer Department, despite its obvious short-comings, was popular with our readers. Accordingly we have been giving thought to the subject and have evolved a plan which we believe might be of general interest, which might be of real help to our readers and which obviates several of the objections raised to the ordinary Question and Answer Department, particularly criticism of answers as being prejudiced or as reflecting upon the intelligence of our editors.

In brief, the plan is as follows:

Beginning in the earliest possible issue, the REPORTER will publish an "Open Forum" for the discussion of technical problems by our readers. Anyone who has a technical problem on which he would like advice, may submit it to the REPORTER and it will be published in the first available issue. Any reader who feels that he has a solution of the problem or a worthwhile comment to make thereon, may forward his reply to us, and if we feel that the reply is suitable, it will be published in a succeeding issue. For each such reply published, the REPORTER will pay a minimum of $2.00.

In case there is more than one answer to the same question, the one covering the subject in the most complete and authentic manner will be published, or if two answers are sufficiently different both will be published. If two answers are considered equally good, the one first received will be given priority.

If this plan is accepted with favor by our readers it should mean that members having problems will receive a variety of suggestions as to meeting them and those of our readers who are technically well informed and who have a reasonable amount of leisure may enjoy the satisfaction of assisting their fellow members and at the same time derive a modest remuneration for their efforts.

We can conceive that the plan may be a decidedly interesting feature to all our readers and hope that it may be favorably received.

It is obvious that in conducting this department the REPORTER will assume no responsibility whatsoever for the accuracy of the answers submitted—it is simply offering a vehicle for the public expression of its readers' opinions.

We suggest that those who have current problems in hand start the department going by submitting them for publication.

Answers when published may be signed by the author's name or will be published anonymously, as the answerers request. In every case, however, the writer's correct name and address must be forwarded to the editor.

Re: Coconut Oil

Daniel McIver, Treasurer and Secretary of the Original Bradford Soap Works, Inc., when interviewed recently stated that "the action of the Ways and Means Committee of the House of Representatives in voting recently to retain the excise tax on coconut oil by a vote of 14 to 11 meant one of two things. The vote meant that the cost of soap production in the United States would be increased 100% which would entail at least a 50% increase in price to the consumer and in the cases of surgical soaps, largely used by hospitals, the increase would run as high as 100% to the consumer because of the large percentage of coconut oil in such soaps.

"Coconut oil constitutes one-fourth of the oil and fat ingredients used in the soap kettle in the United States and it is an absolutely indispensable raw material, it being necessary to employ coconut oil to produce a soap which will lather in the presence of water of the slightest degree of hardness. Thousands of hospitals, laundry-owners, cleaning and dyeing establishments, women's clubs and other consumers organizations protested to the Ways and Means Committee against the proposed excise tax on coconut oil, but their protests were unavailing. The Committee insisted that the coconut oil be shut out of the United States because 22% of the imports were used in the manufacture of oleomargarine."

Mr. McIver commented that "this is tantamount to burning down a haystack to catch a mouse. There is no conflict whatever between the interests of the soap maker and of the dairymen. The soap maker requires coconut oil for soap making purposes and he does not put it into edible channels. A compromise could have been effected at Washington had it not been for the fact that renderers of tallow recovered from the garbage of cities employed the principal lobbyist of the dairymen to present their case at Washington for them. This dairyman lobbyist stated that a compromise allowing the free importation of coconut oil for use in soap making would be unsatisfactory to the dairymen. It is inconceivable that the dairymen who actually milk cows would not have been amenable to such a compromise, but the gentlemen in their employ at Washington refusing to accept same, the effort to obtain reconsideration of the excise tax was defeated in Committee.

"As before stated, if the excise tax goes into effect as proposed it will either destroy the domestic soap industry or increase the price to the consumer in excess of 50%. The domestic soap manufacturer cannot pay a 200% increase in the price of coconut oil without passing it on to the consumer. Since 91% of all the soap produced in the United States is protected by only a 15% ad valorem tariff, this means that there will be a great influx of foreign soap into the United States. How long the domestic soap manufacturer can can stand up against the flood of competition is, of course, problematical, but there is is no gainsaying that the foreigner can undersell him by 50% if the 5 cent tax goes on.

"The American Hospital Association, the Protestant Hospital Association and the Catholic Hospital Association jointly protested against the excise tax on coconut oil, but their protests were ignored along with those of all other consumers. The Hospitals stated in their presentation to the Committee that the 5c per pound excise tax on coconut oil will increase their soap bill in the amount of twenty-five million dollars per annum, which is a very serious matter to them in consideration of the fact that at the present time, the number of paying patients is constantly diminishing and the number of charity patients increasing, which is creating an almost unbearable burden on the hospitals.

"Laundryowners throughout the United States protested because the removal of 25% of the available ingredients of the soap kettle will create a great increase in the price of laundry soap, as it will throw the burden of demand upon the types of fats used specifically in laundry soaps, thus creating a shortage in that field. The increase in prices of soap to the laundryowners will destroy the slender margin of profit which exists for many of them.

"A huge American investment in the crushing of copra on the West coast of the United States and in the Philippines, aggregating at least thirty-five million dollars, will be completely wiped out by the excise tax and the second most important freight item carried by trans-Pacific vessels in the American Merchant marine into Pacific coast ports will be eliminated by the excise tax on coconut oil. Transcontinental railroads running from the West Coast ports will have one of their principal items of freight removed from their loading docks.

"The coconut oil excise tax proposal of the Ways and Means Committee should be defeated when the bill comes up for consideration on the floor of the House of Representatives."

Mr. McIver spent several days in Washington, along with others of the soap industry who are vitally interested in defeating this excise tax, and he now requests that everyone interested in stopping this increase in the price of soap write to their Senators and Representatives to defeat this project.

New Mercerization Theories

That mercerization of cotton is the result of a physical, and not a chemical, change in the fiber is indicated by a scientific study of the problem by Prof. Wilder D. Bancroft of Cornell University and John B. Calkin, a fellow of the Textile Foundation. Their important study has not been completed, but a summary of their experimental work, published in the March number of "Textile Research," explodes a number of theories that have been advanced by other scientists as the cause of mercerization, among them the claim that definite chemical compounds in mass are formed. The authors of this study of "The Action of Sodium Hydroxide on Cellulose" have found many indications that mercerization produces a physically changed fiber which has an increased adsorption surface, that takes up more sodium hydroxide, dyes, etc., from solution than the native fiber.

The same number of this official magazine of U. S. Institute for Textile Research contains a report on "The Sulfonation of Benzoic Acid," this being the first of a series of studies on the orienting influences of the benzene ring by John S. Reese IV, a Textile Foundation fellow. An article reviewing the plans for a research institute as formulated in 1930 by the promoters of U. S. Institute for Textile Research is contributed by C. H. Clark, secretary of the Institute. A regular feature of the magazine is an abstract section covering textile research throughout the world.

Water and Wool Scouring*

By CLEMENT BOLTON

FROM the chemical point of view, water is very much taken for granted in scouring and, in fact, in all the wet processes of wool manufacture. Whether it is hot or cold, and whether it contains acids, alkalis, or dyes, it is considered as just water, a mere vehicle for other things. These others can react amongst themselves, or with the fibers, but the water seems to take no active chemical part. Its role seems to be simply physical or mechanical. In other words, its mass average behavior seems very constant, chemically speaking. Yet it is probable that down in the molecular depths it plays an important chemical part.

Ionization of Water

The formula of water is given as H_2O, graphically H=O=H. It is taken as the typical neutral substance. In our discussion of pH values it was pointed out that the ionization of water is about 1 in 10,000,000, which is so small that the substance is called neutral. The ions, of course, are H + and OH—, and as all the ions of the molecules may be supposed to be mobile and constantly shifting and changing patterns, this very small percentage shows how few get away from the influence of the rest. When a salt, or an acid, or alkali is dissolved in water and becomes highly ionized, it would seem that in the general jostling of the molecules, the molecules of, say, salt, having the molecules of water scattered amongst them, become more separated. A bigger average attains a relatively greater independence. The fact that the greater the dilution the greater the ionization supports this view. In *very* dilute solutions it is supposed that ionization of the solute approaches, and perhaps reaches, 100 per cent. The molecules of the water separate the ions very completely, or, as we may express it, the ions fairly lose themselves amongst the molecules.

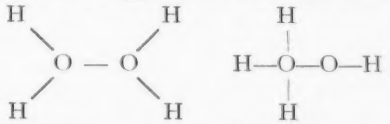
Nature of Composition

Note that the ions which do appear in water are hydrogen ions (often shortened to hydrions) and hydroxyl ions, that is, those which are distinctive of acids and alkalis respectively. The substance itself is neutral. In itself, depending on the way its formula is looked at, water has a composition typical of an acid or an alkali, or a salt. The OH group is also found in alcohols and other compounds. The H functions as a hydride. The oxygen O is, of course, typical of oxides. Thus the simple formula H_2O orients water with a tremendous number of chemical compounds. Water is, in fact, very much in the center of things, chemically speaking. Its importance, therefore, is not quite a matter of chance.

The simple molecular formula H_2O does not, however, quite sum up the nature of water. It represents a molecule of water, as it is when in the form of steam, but of water as a liquid it does not quite tell all the tale; still less of water as a solid. No fewer than five different forms of ice are known, suggesting five different molecular complexes at the base of them. In liquid water, double molecules $(H_2O)_2$ are found, and in ice triple molecules $(H_2O)_3$. Complexes up to $(H_2O)_6$ are probably existent. There is an equilibrium in the proportion of the molecules, depending on one temperature. The solution of any substances in water upsets the equilibrium—in other words, it sets up a certain amount of chemical reaction in the water alone. In the complex molecules, the linkages of the atoms are varied, so that atoms and radicles have varied jumping-off places, and can enter into combination with other chemicals, according to the requirements of these others.

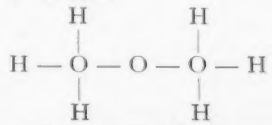
The Gasogenic Molecule

Simple H_2O is sometimes referred to as the gasogenic molecule. The complexes in the liquid state are called liquidogenic. $(H_2O)_2$ is called dihydrol and $(H_2O)_3$ is trihydrol. Two suggested formulae for the former are:—



Dihydron. Hydronol.

Hydronol is considered the more active form. It may be considered as oxonium hydroxide. $H_3O.OH$, and $(H_2O)_3$ could be considered as a basic anhydride of oxonium hydroxide $(H_3O)_2O$.



On this theory the so-called hydrogen ion may really be H_3O +.

Explanation of Versatility

These various arrangements of hydrogen and oxygen, always in the proportion of two H to one O, help to explain the remarkable versatility of water in the chemical sense, and they also give some explanation of its physical behavior. Although it can be looked at as a type of several kinds of compounds (acid, base, etc.), yet in this very fact is the paradox that it is one of the most abnormal substances known to the chemist.

For instance, it is denser when liquid than solid. Ice is lighter than water. The temperature of maximum density is 4 deg. C. At this temperature it is said to be 37.5 per

* From "The Phenomena of Wool Scouring"—The Dyer.

cent. trihydrol $(H_2O)_3$, and 62.5 per cent. dihydrol $(H_2O)_2$.

The weight of one cubic centimeter water at 4 deg. C. is 1 grm.; 1,000 cc. of water at 4 deg. C. becomes 1000.13 at 0 deg. C. and 1043.2 cc. at 100 deg. C. 10 volumes of water at 0 deg. C. becomes 10.9 volumes of ice, hence the bursting of pipes in a frost.

Specific Heat

Water has a higher specific heat than any other common liquid. The average quantity of heat required to raise one gram of water one degree in temperature (between 0 deg. and 100 deg. C.) is called a calorie. The values at 0 deg. and 100 deg. are slightly higher than those in the middle of the range, but the variation from unity is never more than 1 per cent. For all other common materials, the values are much lower.

To convert a gram of water at 0 deg. into ice requires the withdrawal of 79 calories. Conversely, to melt one gram of ice requires an absorption of 79 calories. To turn one gram of water at 100 deg. into steam at 100 deg. C. requires 540 calories, and the volume increases nearly 1,700 times.

The 540 calories which go into the steam are latent, and this explains why steam is so effective for heating cold water. The latent heat comes into use again. One gram of water, in rising from 46 deg. C. to 100 deg. C., takes 54 calories. One gram of steam at 100 deg. C. has ten times that amount latent; its latent heat alone, therefore, is sufficient for 10 grams, and its own condensation will provide another gram at 100 deg. C. If the steam is at pressure it contains still more heat. It is supposed that the latent heat absorbed in boiling is used for the purpose of breaking down the $(H_2O)_n$ molecules to the simple H_2O molecules of steam—a rather subtle manifestation of what molecular complexity can lead to.

Water as "Catalyst"

Many reactions in which water is not considered to be in the end-product will not take place except in its presence. Carbon monoxide and oxygen from an explosive mixture under ordinary circumstances, but if they are perfectly dry they will not explode. Carbon may be heated to dull redness in *dry* oxygen, without showing any flame. Neither sulphur nor phosphorus will combine with oxygen if both the reactants are perfectly dry. The phosphorus does not even show a trace of luminosity. HCl and NH_3 do not combine if dry. In all these cases the merest drop of moisture sets off the reaction violently.

To obtain substances perfectly dry, as in the above conditions, is very difficult. Phosphorus pentoxide, P_2O_5, is about the most efficient drying agent and experiments with it have sometimes had durations extending to years, even to a decade. Many liquids after such prolonged desiccation, have been found to have undergone rather remarkable changes in their behavior. The boiling point, for example, may have risen—by 62 deg. in the case of mercury and 38 deg. in the case of benzene.

Solvent Action

Water has a remarkable solvent effect on solids, liquids and gases. It dissolves traces, at least, of practically everything with which it is brought into contact. In its solvent properties it is superior to all other liquids. As a consequence, there is probably no substance more difficult to obtain in a state of extreme purity. It dissolves the oxides of metals to form hydroxides or bases. The oxides of non-metals are dissolved to form acids. Many salts are dissolved, to form hydrates. It used to be customary to refer to compounds like NaOH and KOH as hydrates, but it was necessary to make a distinction between compounds of an element or radicle with the hydroxyl radicle, OH, and those with water, OH_2. The term hydrate is now confined to the latter.

When an acid and a base neutralize one another the result is a salt plus water.

$$NaOH + HCl = NaCl + H_2O$$

The action is reversible, though it is only noticeable when the acid and the base are of very unequal activity. The reverse action is called hydrolysis. A salt of a strong base and a weak acid hydrolyzes in water to a solution which is basic, e.g., sodium carbonate. Conversely, a salt of a weak base and a strong acid hydrolyzes to a solution having an acid reaction, e.g., cupric sulfate $CuSO_4$. A salt of a weak base and a weak acid may be almost completely hydrolyzed, e.g., in the case of aluminum chloride, still more so with aluminum carbonate, which indeed decomposes completely into hydroxide of aluminum and carbonic acid.

Hydrolysis with Non-Metallic Compounds

Hydrolysis may occur with non-metallic compounds. For example, phosphorus trichloride and water

$$PCl_3 + 3H_2O = 3HCl + H_3PO_3$$

It may also occur with organic compounds; in fact, it is a very important reaction. Fats, like tallow, etc., consisting of compounds of fatty acids and glycerol, can be hydrolyzed by steam into fatty acid and glycerol (glycerine).

Instead of water, H-O-H, the base Na-O-H may be used, and instead of the "salt" of hydrogen being formed (i.e., the acid), the "salt" of Na may be formed. This is what happens when soap is made by mixing together tallow and caustic soda. The process is saponification, but the term is extended to similar reactions when the result is not a soap. In fact, there has been a tendency in organic chemistry to use the word saponification as a synonym for hydrolysis. The latter is, however, the better word. It covers the action of ferments and enzymes and the formation of substances from glucosides (e.g., alizarin from ruberythric acid, the glucoside of alizarin found in madder). In many of these cases of hydrolysis, the substance is made to react with water containing a very small percentage of strong acid. Tallow, for instance, may be hydrolyzed with water in closed vessels at 200 deg. C. or with superheated steam; but with dilute

sulfuric acid the reaction takes places at a lower temperature.

Natural water is never pure. Even rain water contains dissolved gases and brings down "dust" of varying composition with it. The atmosphere above busy manufacturing towns is in a dirty condition and rain washes it. Rain water collected from roofs may have additional dust from them in it. A mountain stream may give a fairly good-quality supply, except that when in flood it will be turbid. If collected in a suitably-made reservoir the turbidity should not be serious. While the stream is in flood it should be diverted and only allowed into the reservoir in a reasonably clear condition.

Colloidal Impurities

Mountain streams may be discolored from peat and this may stain goods in scouring. Treatment in the reservoir with alumino-ferric, and filtration through a sand bed will reduce this coloration. The colored impurities seem to be colloidal and the treatment with alum is a process of coagulating the colloids with the opposite charge of the electrolyte. As we have described previously, alum is very efficient because the aluminum ion has three positive charges Al +++ (this also explains *some* of its power as a mordant). Alumino-ferric is almost entirely sulfate of alumina, and is cheap—we presume because it has not been stringently purified from iron. Care must be taken that it is not used in excess. It is added in order to precipitate the peaty or humic "acids," whose composition nobody seems to know, but one must make certain that the peaty acids precipitate all the alum. Excess of peaty acid would be less deleterious than excess alum. If the alumino-ferric is added at the feed end of the reservoir and some carbonate of soda ("alkali") at the other end—just before the water goes to the filter bed, the danger from the alum will be less. An excess of alkali will not do any harm in scouring and very little in dyeing.

Of course, even a moorland stream, where the water that has descended as rain has travelled quickly over the surface, will contain some dissolved impurities from the soil and rocks. Water which has descended into the earth and reappeared as springs may have a very high content of dissolved matter, depending on the rock formation it has passed through. Public supplies generally come under the head of spring water, so do rivers, but these and canals may contain much other contaminating matter—grease, sewage, etc.

A good water supply—good in quantity and quality and cheap—is a great boon but a rare one, and very often the supply is more notable for a lack of good qualities and a superfluity of bad ones, in which case both filtering and softening may be necessary. The subject is a very big one and beyond our present scope, but a few general remarks may be given.

Individual Treatment Necessary

In the first place, each supply is a problem in itself and requires an analyst's report as a beginning, though even this will probably require repeating, for a supply varies in itself at different times—even, in many cases, during one day. The treatment of each supply must be individual.

Secondly, no treatment plant can be "automatic." It requires oversight and skilled oversight at that, otherwise the efficiency of the plan may not only be poor, but the result may be even worse than without any apparatus. In any case, it is doubtful if 100 per cent. efficiency will be obtained, at any rate, not within a cost that could be called reasonable. It must be remembered that, after all, the impurities in ordinary water are not very great, considered as a percentage. It depends on the nature of the dissolved impurity; water expressed as 99.95 per cent. pure *may* be of 20 deg. hardness.

The chief dissolved impurities are lime and magnesia salts. Many waters contain iron, but good aeration should precipitate most of this. There should not be much iron in a public supply which has come from a reservoir, and in any other supply mere filtering should remove what there is. Of course, any iron that does get through into the works has all the bad features of lime and magnesia, along with the added depravity of bad color. It is lucky that it is one of the most easily removed of impurities—it tends to settle out itself and is easily precipitated by alkali, caustic or carbonate.

Temporary and Permanent Hardness

Hardness in water is usually classed as (1) temporary; (2) permanent. The former consists of carbonates, chiefly lime and magnesia, but sometimes iron. The latter consists of sulfate and chlorides.

Rain can dissolve gases from the atmosphere and among the gases is carbon dioxide, which, with water, forms carbonic acid H_2CO_3. Thus, acidified water can dissolve carbonates which are normally practically insoluble in pure water. The process is usually represented as the formation of (soluble) bicarbonate of lime, $CaH_2(CO_3)_2$, but this formula is simply $CaCO_3\ H_2CO_3$. If the H_2CO_3 is driven off by boiling the $CaCO_3$ precipitates. It can also be neutralized by hydroxide of lime—

$$H_2CO_3 + Ca(OH)_2 = CaCO_3 + H_2O$$

—or by caustic soda

$$H_2CO_3 + 2NaOH = Na_2CO_3$$

In the first reaction, the calcium carbonate formed precipitates and theoretically all the lime comes out, because, the carbonic acid having been removed, that which it held in solution precipitates also. The result (theoretically!) is pure water. In the second reaction, the sodium carbonate formed is soluble and stays in the water. The lime which had been held in solution by the carbonic acid precipitates. The water is now soft, but it is not pure—for it has in it the dissolved Na_2CO_3. This is a point to be watched in all reactions. There is very rarely a complete theoretic clearance of everything from the water, and what is left in solution, though it may not be hard or curd soap, may nevertheless have effects somewhere else (e.g., in the steam-raising plant) that will require watching.

"Permanent" hardness is precipitated by sodium carbonate: $CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$.

If the proportions of temporary and permanent hardness are suitable, caustic soda can precipitate both. It neutralizes the carbonic acid with formation of sodium carbonate, whereupon the "temporary" hardness precipitates. Then the sodium carbonate reacts with the permanent hardness and precipitates it as carbonate, and sodium sulfate and/or chloride remain in solution.

Calcium hydroxide (quick lime plus water) can precipitate magnesium salts.

$$MgSO_4 + Ca(OH)_2 = Mg(OH_2 + CaSO_4$$

—after which sodium carbonate would be required to precipitate the $CaSO_4$.

"Merit Clause" Eliminated

Announcement that the so-called "merit clause" included in the recently approved Chemical Industry Code will be eliminated was made today by National Recovery Administrator Hugh S. Johnson.

"As this Code was reported originally by former Division Administrator Williams it contained the so-called 'merit clause'" asserted General Johnson. "I returned it to the Division in order to have this clause eliminated. Subsequently a report was made by Division Administrator Berry that the merit clause had been eliminated and that Article IX 'in its present form does not violate the established policy of the Administration.'"

Apparently through error of transcription or interpretation, the Code as resubmitted by Major Berry under the above report is still objectionable and Article IX violates the established policy. Therefore, it will be elim-

Ciba Circulars

The Society of Chemical Industry in Basle has recently issued the following circulars, descriptive of their newest products:

Circular No. 401, *Cibacete Yellows 5G Powd. Pat. and 2GN Powd. Pat.* Of these, the 5 G type is said to be especially suited for the production of brilliant greens, which have a good fastness to light and washing. The 2GN type is of much redder shade, but possesses a greater fastness to light and washing.

Circular No. 403, *Neolan Yellow BE Pat.;* this is said to be a particularly soluble and level dyeing type, besides possessing all the fastness properties necessary for men's wear. It shares with the other Neolans a general adaptability for the better classes of wool and worsted goods, where a good all-around fastness is necessary.

Circular No. 404, *Chlorantine Fast Blue 10GL,* said to be the clearest and greenest shade of pure blue, possessing a high degree of light-fastness. It finds use in the production of bright greens on both cotton and rayon.

Circular No. 405, *Chlorantine Fast Violet 8BLL,* a bluish shade of violet, said to have very good fastness to light, in addition to the other good fastness properties common to this series of dyes. It is well adapted for dyeing viscose in sun-fast shades. It is to be noted that it is one of the few violet dyes that may be discharged to a pure white with hydrosulfite.

Circular No. 406, *Brilliant Cyanine 6B,* a neutral dyeing acid wool dye of brilliant royal blue shade, said to have good fastness to water, washing, perspiration and decatizing. The fastness to light is claimed to be better than any acid blue of equal brilliancy.

Circular No. 407, *Rigan Green 3BL,* said to be especially valuable for dyeing streaky viscose, Bemberg or Chardonnet rayons, but reserving acetates.

Circular No. 408, *Cibacete Red GGR Powd.,* a new type of red for acetates. The shade is said to be purer and dye more level than the older types. This type also is said to be dischargeable to a pure white with Decroline.

Circular No. 410, *Direct Bronze G,* a useful shade in a class of easily levelling dyestuffs for cotton or rayon, said to be dischargeable to a pure white.

SAMPLE CARDS:

Card No. 1040—*Ciba and Cibanone Dyestuffs.*

Card No. 1108—*Chrome Fast Colors on Wool Yarns.*

Card No. 1123—*Pyrogene and Thiophenol Dyestuffs.*

Card No. 1126—*Neolan Orange 2R.*

Copies of the above may be obtained from the Ciba Company, Inc.

CLASSIFIED

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

POSITION WANTED: Mr. C. W. Nelson, author of article: "The Production of Vat Dyes on Piece Goods," appearing in this journal November 20 last, now resident in England, is prepared to consider engagement for 12-24 months.

Advertiser possesses practical experience covering every branch of cotton piece goods, with special reference to vat dyeing.

I claim that I could introduce several important ideas not generally known in the Trade, and am prepared to organize any works or dyehouse. Wide experience in all modern styles, including azoic dyeings, imitation mercerized finishes, continuous padding methods, etc.

Salary required £2500 per annum and full expenses.

Replies treated in strictest confidence. Mr. C. W. Nelson, c/o The American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

POSITION WANTED: Foreman finishing-folding and packing cotton—rayons, celanese all grades, bleachery—printworks—silk finishing plants experience. Can offer with my service. German-Swiss method machine not patented. Write for rough diagram. It will surprise you how simple this method is. Henry F. Carr, 148 Milton St., Brooklyn, N. Y.